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## ANÆSTHETICS.

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FESSOR OF GENITO-URINARY DISEASES;  
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HOSPITALS.



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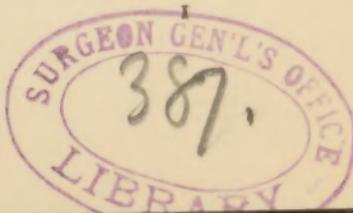
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*Gentlemen:* The various methods of producing anæsthesia for surgical purposes at the present day are deserving of the most careful study and consideration. The number and variety of surgical operations have so enormously increased under the influence of the discovery of antisepsis that the problem of how most safely to produce unconsciousness has become one of correspondingly increased importance. I shall try to review the subject as well as can be done within the limits of an hour, confining myself to the fundamental principles involved and using freely such teachings and writings as are considered authoritative.

The agents employed as anæsthetics may be included under the following heads:

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<sup>1</sup> A lecture delivered to the Graduating Class of the University of Pennsylvania, Session 1888-1889.



1. Alcohol.
2. Chloroform.
3. Ethers.
4. Methylene
5. Nitrous Oxide.

The first four in all probability act in a somewhat similar manner in producing anaesthesia, *i.e.*, they directly affect the nerve centres; but their secondary effects are altogether different.

ALCOHOL may be dismissed in a few words. The narcosis which it produces when swallowed is unfortunately familiar by observation to almost every one, in the shape of profound intoxication, but it may also be brought about by inhalation as is the case with the other anaesthetics. Alcoholic narcosis, however, is much more persistent and consequently much more dangerous than that of the more volatile anaesthetics which are absorbed and eliminated with greater rapidity. Unconsciousness can be produced in this way only by a much greater expenditure of time. The preliminary period of excitement is vastly more prolonged, the patient is far more uncontrollable, and the resulting narcosis will sometimes persist for hours. The drug is therefore not used at the present time as an anaesthetic, and requires no further consideration.

CHLOROFORM.—In this country chloroform is employed as an anaesthetic, by the great majority of surgeons, only in those cases in which the other anaesthetics have failed, or in those exceptional operations, such as staphylorraphy, in which it is especially

desirable to prevent coughing and the hypersecretion of bronchial and laryngeal mucus. It is still used largely in obstetric practice, and is said to be far safer when given to children than when employed with adults. So far as I know no satisfactory explanation of this fact, if it be a fact, has yet been advanced.

Chloroform undoubtedly has certain advantages over ether. It is cheaper, it acts in smaller quantity, its local anaesthetic action is greater than that of ether, and hence there is not so much mucus thrown out from the throat and lungs; it is not so apt to be followed by nausea and vomiting; being less volatile it does not so completely fill the pulmonary spaces with its vapor, and there is less of the suffocating feeling which most patients have when they take ether.

These are, I believe, all the advantages that can possibly be claimed for chloroform. To counterbalance them we have the one all-important fact, that chloroform has killed about one person out of every 2600 to whom it has been administered. The individuals to whom it is safe to give it cannot with any certainty be selected beforehand. In many cases the autopsies have disclosed no evidence of disease of any sort. The patients have simply died "poisoned."

We have, as yet, no conclusive evidence or statistics to enable us to balance the merits of the different anæsthetics in a perfectly mathematical manner. We know that

between the years 1870 and 1885, 184 deaths have been published in England as occurring under chloroform, which is slightly over 12 in a year. The number of times that chloroform has been administered in the same period is not known. At Saint Bartholomew's from 1875 to 1880, chloroform had been used 4810 times with two deaths. Mr. Williams has recorded, as his personal experience, 208 cases of chloro-forming with one death. On the other hand, between 1870 and 1885, 28 cases of death from ether in England alone have been recorded. Saint Bartholomew's tables give 6440 cases with two deaths; Mr. Williams 1050 cases with one death.

Of course, in giving any anaesthetic it is highly important that the lungs, the heart, and the kidneys should be sound. But this is far more important or essential in giving chloroform than in giving any of the others. It has so high a boiling point and is therefore volatilized with such comparative slowness that it is probably never eliminated entirely by the lungs, but only with the aid of the excretory organs generally.

If the lungs have a smaller area than usual on account of disease, just so much more strain is thrown on the kidneys, and if in addition they are contracted or fatty, the danger is greatly increased. It is, however, usually by its depressant action on the heart that chloroform kills, and it seems highly probable that it often does this by

the property which it has been shown to have, of destroying the contractile power of the cardiac muscle when it reaches it in a sufficiently concentrated form.

Various circumstances may greatly affect the degree of its concentration in the lungs and circulation, and thus increase, or decrease, the danger of its employment. Of these the most important are those connected with the character of the respiration of the patient and the circulation through the lungs. For example, a given quantity of chloroform, say one drachm, will exert its greatest effect when the respiration is deep and quick, because the vapor is then carried, in any given moment of time, in larger quantity into the air spaces of the lungs. If, at the same time, the patient, being only partially anaesthetized, stops suddenly after breathing deeply, *i. e.*, closes his glottis and strains, he increases the rapidity of absorption of the chloroform vapor into the blood; or if the movement of blood through the lungs is exceptionally slow as shown by a dusky or congested appearance of the face, the opportunity for absorption will likewise be greater, and the blood will reach the heart overcharged with chloroform, and possibly produce its poisonous effect. A low temperature of the blood of the patient, as in cases of shock, seems to act in the same manner, probably by hastening the condensation of the chloroform vapor in the pulmonary tissues and favoring its absorption into the blood.

A combination of these conditions therefore should put the anæsthetizer, especially one who employs chloroform, on his guard. And, during the preliminary stages of chloroformization, at least, it may be said that a patient who is shocked by injury or accident, who is only partially anæsthetized, whose face is dusky or congested, whose breathing is quick, and who is struggling against the anaesthetic, is in the greatest danger. Many deaths have occurred from chloroform under these circumstances and in this first, or so-called stage of excitement. The second stage is the period of true anæsthesia, during which consciousness and sensibility are abolished, the muscles relaxed, the pulse weak, the breathing often shallow and feeble; it is during this stage that operations should be performed and great care observed to limit the quantity of chloroform used to the least amount necessary to continue the condition without causing it to pass into the third stage, or that of narcosis in which there is increasing weakness of the pulse, stertorous breathing, complete abolition of the reflexes and other indications of profound involvement of the nerve centres. This is still more dangerous than either of the other stages. There may be no premonitory symptoms of danger, or it may be indicated by either great paleness or congestion of the face, or by marked irregularity and failure of the pulse.

It seems probable that the position of the

patient during chloroforming has much to do in increasing or diminishing the risks of perspiratory or cardiac failure. It is said that during gynecological and obstetric operations, in which the patients are kept lying on the left side, the pulse and respiration have been more satisfactory during anæsthesia from chloroform than when the patients have taken it in the usual position. A celebrated surgeon is said to have noted the fact that all of his patients who, when in danger of death from chloroform, were rolled upon the left side recovered, while those kept on their backs or placed in other positions not infrequently died. It may be that the view which attributes special safety to the drug in obstetrical cases took its origin in the fact that the customary obstetrical position in England is upon the left side. Dr. Buxton thinks that the influence of position is unquestionably important and is due to the fact that the condition of the heart, lungs, tongue, and larynx is more nearly correct physically and physiologically when a patient is placed in the left lateral position instead of on the back. He mentions as corroborative the circumstance that during sleep and in all conditions in which respiration is shallow and is carried on at a disadvantage, most persons instinctively assume the lateral position. He adds that the difference in the condition of the pulse and respiration of patients chloroformed in the dorsal and lateral positions has been so

striking as gradually to force on one the lesson of placing every patient where it is possible on the left side before chloroforming him.

Various apparatuses have been devised for the administration of chloroform, most of them too complicated and expensive for practical use. In my opinion the safest and therefore the best way of giving it is by pouring a few drops at a time upon the surface of a folded towel or napkin and, holding it at first two or three inches from the nose of the patient, gradually lessening the distance as its effects begin to be produced. It should always be given while the patient is in a reclining or recumbent posture, being especially dangerous on account of the tendency of heart failure if it is given to persons in an erect or semi-erect position. During its administration certain indications should put the anæsthetizer immediately upon his guard. These are, in the order of their danger, first, failure of the pulse; second, sudden change in the color of the face, extreme pallor denoting a tendency to syncope while a dusky or purplish face indicates obstructed respiration; third, stridulous breathing; this if very marked may indicate spasm of the glottis either from direct irritation by the chloroform vapor, or from reflex action caused by the operation which may have been begun; or the same breathing may be produced by the falling backward of the tongue and epiglottis, which thus cover more or less completely the aperture of the larynx.

These conditions, while more likely to occur during anaesthesia from chloroform, may also be produced by ether and other anaesthetic agents. The duty of the anaesthetizer should be the same in every case. He should promptly take the following precautions:

1. Remove the anaesthetic and secure a plentiful supply of fresh air about the head and face of the patient.
2. Place the fingers back of the angles of the inferior maxilla and press it strongly forward, thus carrying with it the tongue.
3. Seize the tongue near its tip and draw it forward.
4. Lower the head of the patient or, if the case is a grave one, raise the lower limbs, pelvis, and trunk higher than the head and shoulders.
5. Begin the movements of artificial respiration, catching the arms at the elbows and carrying them outward and upward until they almost meet in a line above the head, then bringing them down again until they touch the sides of the chest; at each movement moderate pressure should be made upon the lower portion of the sternum. These motions should be repeated not oftener than 16 or 18 times per minute. This time honored method of artificial respiration has never been improved upon, and a large quantity of air can be made to pass through the lungs with each of these movements.
6. Dash alternately hot and cold water on the front of the chest.

7. Give hypodermics of strychnia.
8. Rub the extremities strongly toward the heart.

9. Compress the abdominal aorta.

The last two methods are intended to keep the blood in the region of the heart and great nerve centres where, at least during the period of shock, its presence is vitally important.

10. Faradize the diaphragm, placing one pole on the pit of the stomach and the other over the root of the neck.

11. Small lumps of ice, or "ice suppositories," inserted into the rectum, will sometimes by reflex action bring about deep breathing.

12. As soon as swallowing returns use diffusible cardiac stimulants—alcohol, ammonia, and possibly digitalis. The majority of these directions apply also to difficulty arising during the use of ether, which we may now consider.

**ETHER.**—Ether is the chief anæsthetic employed in practical surgery in this country. It produces when inhaled a succession of conditions very like those described as caused by chloroform, but with important differences.

1. A stage of excitement preceded by a feeling of strangulation or of suffocation, with a burning sensation in the fauces, lachrymation, often more or less coughing, accompanied by excessive secretion of laryngeal and bronchial mucus. In other words,

we have during this period of excitement the evidences of the local, irritating action of the ether upon the mucous surfaces with which it comes in contact. The patient may at this time pass into a condition closely resembling natural sleep, often mistaken by inexperienced etherizers for one of true anaesthesia. During this condition the patient can easily be aroused and is sometimes quite conscious of all that is going on about him. Indeed, during the whole of this stage the special senses are often almost supernaturally acute, and a remark made by the surgeon or his assistant will often be responded to promptly and intelligently by the patient.

2. This passes after a variable interval into a period of unconsciousness, at first accompanied by some degree of muscular rigidity, but soon followed by relaxation. The complexion should be unaltered ; the pulse is usually increased in force and volume.

3. If the etherization is pushed and a large quantity of the anaesthetic employed a stage characterized by stertor and profound coma follows, the pulse being still strong and full but the face becoming flushed or purplish. This stage should only be occasionally and accidentally reached during etherization, and should be the signal for the temporary withdrawal of the anaesthetic and immediate inspection of the respiratory conditions with careful attention to

the mouth and throat and watchfulness to see that the tongue is well forward, and the movements of breathing deep.

It cannot be said that ether is absolutely safe and harmless under all circumstances, as there have been a number of deaths reported from its use or, at least, during its use. In the great majority of these cases the exact responsibility of the anaesthetic itself has never been determined.

In 1861, a committee of the Boston Society for the Improvement of Medical Science reported that after a labored search they had learned of no case which was unquestionably and unavoidably fatal from the breathing of pure sulphuric ether. They considered two conditions essential to placing the responsibility of any case of death upon the anaesthetic: 1. That the event should occur while the patient is actually anaesthetized. 2. That the circumstance of its occurrence should be inexplicable by any phenomena of disease or by the operation. Very few, if any, reported cases comply fully with these conditions.

The deaths recorded by Turnbull and Lyman in their treatises, and by Jacob (*British Med. Journal*), are either uncertain in their relation to etherization, or were caused by asphyxia, or more rarely by syncope.

Druet (*Des Contraindications de l'Anæsthesie*, 1880) and Kappeller (*Deutsche Chirurgie*, 1881) give no new light on sudden

deaths occurring during anæsthesia, and accompanied by cessation of respiration. The cases of Hunt, Morton, Levis, Hutchinson, Norris, Sims, Emmet, and others, are all instances of death after anæsthesia, at periods ranging from two hours to eighteen days, and possibly associated with nephritis.

One reported by Allier and two by Post occurred during operations for tumors of the neck. In connection with these the observation of Schiff should be remembered, that when animals are anæsthetized, pinching the skin of the neck will at once arrest both respiration and the action of the heart.

In several recorded cases, while herniotomy was being performed, the patient vomited and died. Mr. Marcus Gunn has suggested that as the vomiting of acute intestinal obstruction results from a powerful descending impulse of the vagus, and as sudden arrest of the heart's action in diastole is also known to be produced by such an impulse, we may expect to meet with this association of vomiting and sudden heart-failure during as well as before and after anæsthesia. The same result has occurred even more frequently under other anæsthetics.

Warrington Hayward records a death during etherization from the sudden failure of respiration owing to the occurrence of an epileptiform spasm of the respiratory muscles, whereby the chest was fixed in the

position of expiration. Nothing was discovered either at the time or at the autopsy, which gave any clew as to how the fatality could have been avoided.

The doctrine of cerebral inhibition advanced by Brown-Séquard should not be overlooked in its application to the few cases of sudden death during etherization in which the autopsies failed to explain the accident. He has shown that there is an arrest or suspension of function in the nerve centres, muscles, and nerves, taking place without demonstrable organic change, and following immediately upon irritation of the nervous system at some point more or less distant from the part in which the effect is observed. He attributes to this cerebral inhibition the cases of sudden death and "death without agony" which are analogous to the loss of intellectual activity that occurs in epilepsy. Such death may be produced in animals by a prick of the ventricle of Arantius in the floor of the fourth ventricle.

But one instance of death during etherization has come under my immediate notice. A middle-aged man, apparently healthy, came to Philadelphia from the northern part of this State to have an operation for the relief of hemorrhoids performed by Dr. Agnew. After the customary preparations, the administration of ether was begun, and progressed until the second stage was reached, muscular rigidity not having

entirely disappeared. Sensation having been abolished, however, the operation was begun and one hemorrhoid was ligated, when the patient suddenly ceased to breathe. Every effort was made to bring about natural respiration, but without success. The entire quantity of ether given did not exceed four ounces. The autopsy showed that death had resulted from an apoplexy into the fourth ventricle, a small coagulum being found in that position and resting upon the respiratory centre. The vessels of the circle of Willis were brittle and atheromatous, as were also the vessels of the entire brain. The increased vascular tension produced by the ether was probably the immediate cause of death in this case, but of course the anesthetic should not be held accountable for the death, as any other condition which would have increased the blood pressure would have produced the same accident.

Dr. Fritz Feuter has recently published an elaborate article upon ether anaesthesia, recording his experience in a large number of cases. He has always employed a large face mask, around the edges of which a folded towel is laid to prevent evaporation of the drug.

The following four points were separately dealt with, as being of most importance: First, the time from the beginning of anaesthesia until anaesthesia is produced. Second, the quantity of ether necessary for this. Third, the total quantity of ether

used ; and fourth, the duration of the anaesthesia. His method of administration is as follows: From a graduated bottle about 50 Cem. is poured upon the mask (for an adult, for children half this quantity is sufficient). The mask is then slowly brought down to the face so that the patient gradually becomes accustomed to the fumes ; this does away with that painful choking which always occurs if the mask is abruptly placed upon the face. So soon as the mask is well over the face a folded towel is placed around it, and the mask is not removed again until there is complete relaxation of the extremities. In this way the patient is continually inhaling ether fumes, for even his exhalations are partly reinhaled, and assist in producing anaesthesia. With these precautions carefully adhered to, the author has invariably found that complete anaesthesia could be induced within two minutes. More than this, the amount of ether subsequently required to maintain unconsciousness is remarkably small. Often in operations of over a half hour's duration, and even longer, no addition of ether was necessary.

In his opinion the two most important points upon which the success of etherization depends are the concentration of the fumes and the non-removal of the mask. The nausea following etherization he believes to be due to the swallowing of saliva which is filled with ether, the secretion being greatly increased by the drug ;

naturally, therefore, the less ether used the greater probability that nausea will not be produced; and indeed his experiments seem to justify this conclusion, for in one hundred and fifty cases vomiting only occurred in ten, and in two of these the patients had taken a meal immediately before the operation. In quoting the statistics of other clinics, he states that out of five hundred and fifty-three cases vomiting occurred in one hundred and forty-eight. Feuter continues by giving a list of personal observations which differ but slightly from those of other practitioners. One fact, however, deserves special notice, viz., he has observed in several cases that when the patient had taken a moderate quantity of alcohol just previous to the operation that the anæsthetization was greatly accelerated; indeed, in one instance hardly a minute passed before the patient was in a complete stupor. Emmet was the first to point out the danger of etherizing patients affected with nephritic troubles. He claims that it is absolutely necessary to examine carefully the urine of such patients before operating, and holds that the presence of albumin is a positive contra-indication for the use of ether, and direct indication for the use of chloroform. Other authorities are of the same opinion. In direct contradiction of the above statements, Feuter declares that he has frequently etherized patients with albuminuria without dangerous symptoms resulting.

Dr. Robert Lovett has reported lately some careful observations in a series of sixty consecutive cases at the Boston City Hospital. He used two methods; one, which he calls the gentle method, in which the ether was given slowly and cautiously; the other the "forcible" method, in which the cone was at once applied closely to the nostrils and mouth of the patient. The former method required an average time of 9.3 minutes and an average amount of 25 ounces for complete anaesthesia. The latter only required 4.4 minutes and 1.5 ounces, but the choking sensation was very much aggravated and the patients were very apt to react and struggle violently if they got only a breath of air.

I may say that this experience about corresponds with that of Dr. Agnew and myself in the use of a rapid method by which the ether contained in a bottle was dropped into a bucket of hot water by the bedside of the patient, the vapor being conveyed by a long flexible tube to a mask placed tightly over the mouth and nose of the patient. Our average time for producing insensibility in some dozens of cases was considerably less than a minute—about 43 seconds, and was often within a half-minute; but the condition was rather one of asphyxia than of true anaesthesia; the distress of the patients was very great, and the evidences of excessive increase of vascular tension were so unmis-

takable and sometimes so alarming that after a fair trial we gave up the method, believing that no economy of time or of ether would compensate for the slightest increased risk to the patient.

On the whole, it may be said that there is no perfectly satisfactory evidence that ether *per se* ever kills, and although it undoubtedly may do so by producing asphyxia, in the vast majority of cases it will do this so slowly and give such marked evidence of its threatening action that every opportunity will be afforded the etherizer to avoid or prevent it.

There is hardly a case in which ether can not be given with safety, but there are certain classes of cases in which there is special danger. These are: 1. Very old people with emphysema, fatty heart, hypertrophy or valvular disease of the heart. 2. Persons with marked tendency to weak heart action or syncope. 3. Persons with extensive lung disease, or with lungs greatly tied down by old pleuritic adhesions. 4. Habitual drunkards. 5. Persons who as the result of alcohol, syphilis, gout, rheumatism, or old age have marked evidences of extensive atheromatous disease.

In the presence of any of these conditions ether should be given very slowly with a large admixture of atmospheric air, and with great attention to the pulse, complexion, and the movements of breathing. The following rules, many of them almost

self-evident but all of them important, apply to the preparation of a patient not only for etherization but for the administration of any anæsthetic.

1. The stomach should be empty. No hearty meal should have been taken for at least six or eight hours before the operation. It is a good rule to insist that all nourishment taken on that day shall be liquid or nearly so, and in many cases it is well to limit the patient to a glass of milk taken early in the morning. This precaution lessens the risk of solid morsels of food being drawn into the air passages during vomiting; makes vomiting less frequent and severe; and diminishes subsequent nausea. In addition, it may be said that the presence of any large quantity of food in the stomach may embarrass respiration by interfering with the action of the diaphragm.

2. Loosen all garments that could in any way impede the movements of respiration or those, such as tight collars or neckbands, which could obstruct the flow of blood through the great vessels of the neck.

3. Remove false teeth or plates from the mouth. Never neglect to inquire as to their presence, no matter what may be the apparent age of the patient.

4. Keep the room at a temperature of at least 68° F. or 70° F., or if the operation is to be a prolonged one at 72°. Practically this is an excellent rule because patients often take cold by exposure during ether-

ization. There is also an additional theoretical basis for it in the fact that when the blood and pulmonary tissues become saturated with ether, evaporation takes place from the surface of these tissues, causing a rapid loss of heat. If the air inspired is warm this supplies the heat necessary to volatilize the ether; if the air is cool the heat of volatilization is taken from the surrounding tissues, quickly chilling them, producing violent contraction of the capillaries, prolonged stasis, engorgement of the right side of the heart, and asphyxia.

5. Have the room perfectly quiet. The preliminary stage of etherization is, as has been said, one of acute sensitiveness to external impressions, and may be greatly prolonged by noise, bustle or excitement in the room.

6. Always examine the heart and lungs, and if the operation is to be severe or prolonged, examine the urine previously.

7. See that no light or flame is near the ether, especially on a lower level.

8. Quietly tell the patient in advance what to expect. Explain the suffocative feeling, mention that it is of almost invariable occurrence and is of no importance; describe the proper method of breathing through both the mouth and nostrils; caution the patient against struggling and resisting. Do this quietly and gently, and it is astonishing how often it will secure such intelligent co-operation on the part of the

patient as will make the etherization rapid and easy.

9. Have an assistant ready to render whatever aid may be required, and, if inexperienced, caution him against the use of unnecessary force.

10. Of the various apparatuses employed for the purpose but two need be considered. One of these, that devised by Dr. Allis of this city, consists of a wire frame work, large enough to cover the lower part of the face and through which a strip of bandage has been passed to and fro so that numerous folds are exposed to the wetting action of the anæsthetic. These large evaporating surfaces, the thorough admixture of air, and the economy of ether are the three most definite advantages of this excellent little apparatus. An ordinary towel if folded into a cone, an aperture being left at the apex large enough to insert a finger, answers every purpose in private practice and obviates the necessity for carrying the more cumbersome inhaler.

11. The etherizer should watch three things—the breathing, the complexion, the pulse. When the breathing is regular and full without snoring, there can be little if any danger; if it is shallow and interrupted, watchfulness should be redoubled and a plentiful admixture of air given with the ether. If it ceases, the anæsthetic should be instantly removed and the tongue drawn forward; if respiratory movements do not begin, artificial respiration

tion should be employed. If the face is very pale and the skin cool, the head should be lowered; if the complexion is livid or purplish, the head should be raised slightly, a freer supply of air given and the tongue and lower jaw brought forward. In case of failure of the pulse the head should be rapidly lowered, the ether immediately withdrawn, and hypodermics of whiskey and digitalis administered. Occasionally in patients who have been etherized after having eaten heartily, a condition may be noticed which includes to all appearances several of these elements of danger, but which is precedent to the act of vomiting; the breathing becomes irregular and interrupted, the face cold and pallid, the pulse almost indistinguishable. In the vast majority of cases this is followed by an expulsion of the contents of the stomach and then by the disappearance of these alarming symptoms. It should not be forgotten, however, that in exceptional cases death may occur during vomiting, possibly, as has been mentioned above, from the descending excitation of the pneumogastric arresting the heart's action in diastole. This affords an additional reason for forbidding the taking of food for some hours previous to the administration of an anæsthetic.

A recent suggestion of Dr. Benjamin Howard, as to the cause of death in certain hitherto unexplained cases of fatality during anaesthesia, seems to me worthy of the most

careful consideration. His views are founded upon his own observations and upon those of Dr. R. L. Bowles, made many years ago in conjunction with Drs. Fox, Hunter and Marshall Hall. Dr. Bowles claims precedence, I believe, for his work, but agrees in the main with Dr. Howard's views, which are as follows: A certain number of cases of apnoea and death are due to falling backward of the epiglottis, a condition often unrecognized, and almost surely fatal if unrelieved. There are many reasons for believing that traction on the tongue or pushing the jaw forward, while of the utmost value when the tongue itself is the obstructing body, do not affect the position of the epiglottis in these exceptional but equally dangerous cases:

Traction on the tongue is ineffectual because:

*a.* The tractile force supposed to be exercised upon the epiglottis is arrested chiefly by the *fraenum linguæ*, and through the muscular fibres within it is expended upon the inferior maxilla into the genial tubercles of which they are inserted.

*b.* The surviving force is expended almost entirely upon, and intercepted by, the anterior pillars of the fauces.

*c.* For any tractile force which may survive, a continuous and sufficient medium for its transmission to the epiglottis is wanting.

Extension of the head and neck is the

only sure means of causing instant and complete elevation of the epiglottis, because: by a three-linked chain, in which the hyo-epiglottic ligament is the lower link, the body of the hyoid bone the central link, and the combined genio- and mylo-hyoidei muscles the upper link, the epiglottis is so connected to the body of the inferior maxilla, that above a certain point, as the body of the lower jaw is moved upward, the epiglottis instantly, irresistibly, and inevitably moves upward exactly in unison till it is erect. The violent wrenching asunder of the clenched teeth, in proportion as it depresses the body of the inferior maxilla, antagonizes a distinct effort of Nature to maintain the elevation of the epiglottis.

Having, by bringing the patient to the edge of the table or bed, or by elevation of the chest, provided that the head may swing quite free, with one hand under the chin and the other on the vertex, steadily but firmly carry the head backward and downward. The neck will share the motion, which must be continued until the utmost possible extension of both head and neck is obtained. Assuming the mouth to be shut and the inferior border of the inferior maxilla to be at a right angle with the cervical column, as in the average recumbent posture, the head must be continued to be extended from thirty to thirty-five degrees more before it is possible for the epiglottis to be affected at all. Not until after the skin from the sym-

physis to the sternum is quite tense do the relaxed muscles in question beneath it become tense at all. These being tense, from this point the elevation of the epiglottis begins.

In a nut-shell: Make the line of skin from the chin to the sternum as straight as it can be made, and the complete elevation of the epiglottis is assured.

By extension of the head and neck carried to the utmost, the remaining obstructions from the backward-fallen tongue, the velum palati, and uvula, are also simultaneously removed, and the entire pharynx is enlarged throughout. Because: *a.* The tongue, the dorsum of which before fell by gravitation upon the then horizontal posterior wall of the pharynx, falls upon the now horizontal arch of the palate. *b.* The velum palati, by means of the great tension of the palato-pharyngei muscles, is pulled away from the posterior wall of the pharynx, the entire membrane being stretched tightly forward and downward, behind part of the dorsum of the tongue, helping to complete the shutting of the tongue out of the pharynx and into the mouth, and together with its dorsum forming a partition—the anterior wall of a new air-way, thus created and maintained. *c.* The pharynx, anteriorly, from the base of the tongue to the cricoid cartilage, is stretched strongly forward by the extreme tension of the sterno-thyroidei muscles.

Dr. Howard summarizes his interesting paper as follows:

1. Contrary to universal belief, traction of the tongue cannot raise the epiglottis.
2. By sufficient extension of the head and neck, whether by volition, instinct, reflex action, or by the effort of another, whether in the healthy, the dying, or the dead, the epiglottis is instantly, and beyond prevention, made completely erect.
3. By complete extension of the head and neck the tongue and velum are as respiratory obstructions, simultaneously with the epiglottis, removed; and without a moment's delay the entire air-way can be straightened, enlarged, and be made free throughout by the nearest person.
4. If syncope happens to be the chief factor, or only incidental, this also gets thus the quickest and best corrective.

He expresses the hope and confident belief, that the facts above submitted will be found to be permanent additions to our means of averting death.

In the *British Medical Journal*, Jan. 26, 1889, Mr. Frederic Hewitt calls attention, one, to the occasional impossibility of adopting Howard's suggestion, on account of tonic spasm of the muscles of the neck, jaws, etc.; and two, to the danger of trusting to a post oral (or nasal) air-way which might so readily be occluded by tumefaction of the mucous membrane, by mucus, or by morbid conditions. Drs. Martin and Hare,

in the *Medical News*, March 2, 1889, reaffirm this latter statement, recommend moderate instead of forced extension of the head and neck, so that space may be left between the tongue and palate to permit of breathing through the mouth, and the simultaneous pushing forward of the hyoid bone and the lower jaw. If obstruction to breathing still persists, the tongue should be at once drawn or pushed forward by force exerted upon its dorsum posterior to the anterior half arches of the palate. The subject is an extremely interesting one, and will bear further investigation; but it would seem now to be fairly well established that in the main Dr. Howard's conclusions are justified, and that his method in the majority of cases and in the absence of nasal obstruction is at once the simplest and the most efficient.

12. The etherizer should attend strictly to the anaesthetic, and unless of long experience and perfect self-possession, to nothing else.

13. Etherization is complete when the arm raised from the side drops helplessly, and when the orbicularis palpebrarum fails to respond when the conjunctiva is touched.

14. After this time the ether should be given in small quantities and with plenty of air.

15. With the completion of the operation the responsibility of the etherizer does not end, although it is not uncommon to see him walk away from the operating table or

bedside to inspect a tumor or look at a wound, or aid in washing and cleaning instruments. He should only leave the patient when his place can be taken by a trained and experienced nurse, and should even then for some little time be within call in case of emergency. The vomiting which frequently follows etherization is itself distinctly dangerous if any food has been taken. The patient, incapable of intelligent movement, can readily perish from asphyxia caused by the inspiration of solid portions of the ejecta, and should be carefully watched with this possibility in mind. Then, too, during the intoxication and excitement, which often constitute a distinct stage preliminary to a return of consciousness, he will require careful supervision to prevent him from doing himself harm.

The pain or smarting of the wound will at once draw his attention in that direction and he is very apt to attempt to remove the dressings. The records of surgery show many distressing cases in which this has occurred. One of them, which always seemed to me to be peculiarly horrible, is that of a patient who, being left alone immediately after an operation for strangulated hernia, tore off his bandages, opened the wound and actually pulled out yards of his own intestines.

**METHYLENE.**—With this anæsthetic we have had but little experience in this country and I believe that has not been very favorable.

It was introduced to the profession twenty years ago by Dr. Richardson, of London, who, after a long series of experiments, concluded that its action was more rapid than that of chloroform and that it produced a more prolonged and profound narcotism, but rapidly escaped from the system, and was accompanied by an equally rapid return of consciousness. Deaths have been recorded from its use both here and abroad, as well as from the use of the methylene ether, a mixture of methylene dichloride and absolute ether, also introduced by Dr. Richardson. I have recently seen this anæsthetic administered by Dr. Day, one of the physicians to the Samaritan Hospital in London, who has given it in between 1200 and 1300 cases without difficulty of any kind. He has reported the interesting fact that twelve drachms is the largest quantity he has ever administered in an operation lasting one hour. This agrees with curious accuracy with the statement made by Dr. Richardson as long ago as 1867, when he reported the quantity used in surgical operations as averaging about one drachm every five minutes. In the case which I saw there was no apparent period of excitement, the patient coming rapidly under the influence of the anæsthetic and almost as rapidly recovering consciousness. Dr. Day watches particularly the color of the face and the character of the respiration, paying little or no attention to the pulse; although experiments

on the lower animals seem to show that when methylene kills it does so by paralyzing equally the circulation and respiration. I have had absolutely no personal experience with this anæsthetic, but am disposed to reject it as somewhat more dangerous than ether, and without sufficient advantages to counterbalance the increased risk.

**NITROUS OXIDE.**—This is made by heating nitrate of ammonium in a retort until it decomposes into watery vapor and the so-called laughing gas. The latter collected in a rubber bag or other proper receiver may then be administered as an anæsthetic by inhalation. It would seem from chemical considerations, nitrous oxide being a stable compound at the temperature of the body, and from experimental observation, dogs dying in it in precisely the same time as when put in nitrogen, that nitrous oxide acts by producing asphyxia, or at least by preventing oxidation of the blood. There is, however, no doubt, a primary effect of specific stimulation of the nerve centres as shown by a period of exhilaration, from which it derives its familiar name. There are a few reported cases of death during, or after the inhalation of nitrous oxide, but, not more than three, I believe, and even these are more or less doubtful. In one of them there was found extensive fatty degeneration of the heart; in another no autopsy was made; and in the third only two inhalations of the gas had been taken when the

patient died after the extraction of teeth, probably from syncope produced by nervous shock. In this city at the rooms of certain dental operators enormous numbers of persons (nearly one hundred and forty thousand) have taken the gas without a single death.

The stages produced by this anæsthetic are two: 1. Exhilaration, or the development of the peculiar mental excitement, which is usually cheerful and often boisterously so. 2. Unconsciousness, lasting from two to four minutes, during a portion of which time there is a period of muscular relaxation which is, however, never so complete as under the other anæsthetics. The most common danger associated with the administration of this gas is that arising from a spasm of the muscles leading from the base of the tongue to the hyoid bone and pharynx, producing a condition known as "swallowing the tongue." This sometimes occurs with great suddenness and if unrelieved threatens death from asphyxia. The tongue should of course be immediately drawn forward by forceps and held there until the spasm disappears or the patient recovers consciousness. In cases of extensive heart disease the danger of fatal syncope should be borne in mind, and similarly the risk of asphyxia should be remembered in cases with grave pulmonary troubles. On the whole, however, nitrous oxide may fairly be said to be the safest of all known

anæsthetics within the limitation of its present use, which is chiefly in the performance of such trifling operations as the opening of boils, abscesses or felon, the removal of small epitheliomata, the division of fissures of the anus, or the extraction of teeth.

In *résumé* I may formulate the following conclusions :

1. As a rule ether, as the safest of the more powerful anæsthetics, is to be preferred ; the lessened risk to life more than counterbalances its minor disadvantages.

2. Chloroform may be employed when ether has failed, or cannot be procured, or when there is a distinct record of serious trouble during a previous etherization. It is possibly safer in children than in adults, and it is said to be exceptionally adapted for administration in obstetrical cases. It has some distinct advantages over ether in cases of stenosis of the larynx or trachea, and may be considered in those cases of emergency in which an operation has to be performed a short time after a solid meal.

As secondary indications for its employment the following may be mentioned :

*a.* Protracted operations about the mouth, jaws, nose, or pharynx which necessitate the mouth and nose being uncovered.

*b* Operations needing the employment of the actual cautery, in the vicinity of the mouth.

*c.* Severe bronchitis, emphysema, or asthma.

- d.* Extensive renal disease.
- e.* Marked atheroma.

3. Nitrous oxide should be employed in operations which can be completed in from two to five minutes.

4. Methylene, methylene ether, and the various anaesthetic mixtures, such as that of alcohol, chloroform and ether, are not so safe as ether alone, and have no decided advantages to compensate for the increased risk.

